

but in text cites Ehrmann's "notebook" as stating "Laja, Peru" [sic]. Holland questioned this as possibly "Loja" [Ecuador]. The holotype's labels, not figured by Holland (but shown here in Fig. 1B) appear to say "Loja" [Ecuador], compatible with data on two paratype males (CMNH) labelled "Rio Bamba, Ecuador".

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REPEATED COPULATION IN AN ORANGE HAIRSTREAK, *SHIROZUA JANASI*: A CASE OF MATE GUARDING?

Additional key words: Lycaenidae, mating, behavior.

In butterflies, multiple copulations are common not only in males (Svärd, L. & C. Wilkund 1986, *Behav. Ecol. Sociobiol.* 18:325-330) but also in females (Burns, J. M. 1968, *Proc. Nat. Acad. Sci. U.S.A.* 61:852-859; Ehrlich, A. H. & P. R. Ehrlich 1978, *J. Kans. Entomol. Soc.* 51:666-697; Thornhill, R. & J. Alcock 1983, *The evolution of insect mating systems*, Harvard Univ. Press, Cambridge, Massachusetts, 547 pp.; Drummond, B. A. 1984, pp. 291-370 in Smith, R. L. (ed.), *Sperm competition and the evolution of animal mating systems*, Academic Press, Orlando, Florida, 687 pp.). However, within-a-day repeated copulations are very rare in both sexes (Svärd & Wilkund, above; Fujii, H. unpubl. data).

Recently, Tanaka and Unno (in Fukuda, H., E. Hama, K. Kuzuya, A. Takahashi, M. Takahashi, B. Tanaka, H. Tanaka, M. Wakabayashi & Y. Watanabe 1984, *The life histories of butterflies in Japan*, Vol. 3, Hoikusha, Osaka, 373 pp., Japanese, English summary) observed that females of an orange hairstreak, *Shirozua janasi* (Janson) soon copulated with other males after preceding copulations. Such immediate remating seems to be exceptional in butterflies.

In the summer of 1986, I observed repeated within-pair copulations in *S. janasi*. This paper describes mating behavior in *S. janasi* and suggests that mate guarding is a possible consequence of remating.

Shirozua janasi is the only omnivorous species in the tribe Theclini. Like other Theclini, it has one generation per year, and imagines are on the wing from late July to September (Fukuda et al., above).

Field observations were made in secondary forest including *Quercus serrata* Murray (Fagaceae), *Pinus densiflora* Sieb. et Zucc. and *Larix Kaempferi* (Lamb.) (both Pinaceae), at Sakai village, Nagano, Japan in August 1986.

The male of *S. janasi* flies 3-10 m above the ground and alights just behind the female. This has been called a patrolling-type mate-locating strategy (Scott, J. A. 1973, *J. Res. Lepid.* 11:99-127; Fujii, H. 1982, *Yadoriga* (107/108):1-37, Japanese). Then the male's wings are held open about 30° apart and fluttered. The male moves slowly to the side of the female, bends its abdomen towards the tip of the female's abdomen, and copulates (Fig. 1). This courtship sequence usually ends in successful copulation within 5 sec.

During the survey, five courting pairs were found, and all copulated thereafter. At intervals after copulation began, I disturbed these pairs by approaching or touching them with my fingers until they separated or flew away *in copula*. As shown in Table 1, most

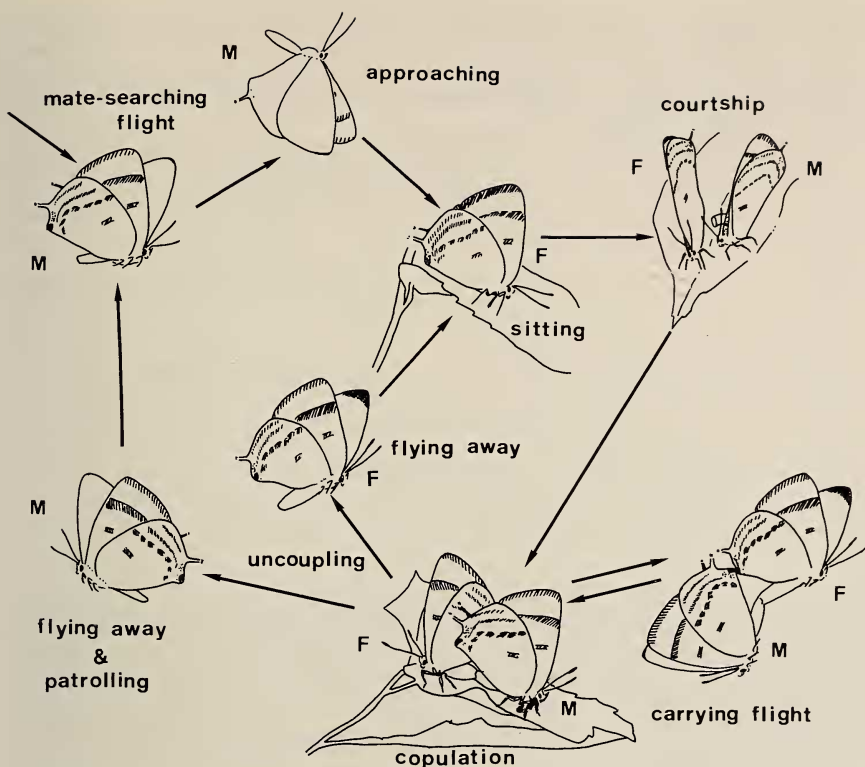


FIG. 1. Sequence of repeated copulations in *S. janasi*. M: male, F: female. Further details in text.

pairs (No. 1; No. 2, 1st & 2nd copulations; No. 3, 1st & 2nd; No. 4, 1st; No. 5, 2nd) were separated easily when disturbed within 10 min after they initiated copulation. In contrast, the pair (No. 5, 1st copulation) that had been copulating more than 30 min was not easily separated. Instead, it usually flew away *in copula*, during which the female always carried the male. Possible mate guarding was observed when the pair was separated as a result of my disturbance: an uncoupled male flew away but returned immediately to where the male had copulated just before. An uncoupled female from a disturbed pair also flew away from the place where it had copulated (usually a leaf), but the female rarely moved so far. Therefore, a returned male could usually find its previous partner, and then the male courted and mated the same partner again (Fig. 1). Such behavior was observed in four of the seven separated pairs, including not only pairs that had copulated for less than 10 min but one pair that had copulated more than 150 min and then remated twice (Table 1).

According to Tanaka and Unno (Fukuda et al., above), copulation in *S. janasi* usually starts within about 10 sec and ends within 10 min of first contact. In this study, most pairs ended copulations within 10 min as a result of my disturbances. It should be noted, however, that the 1st copulation of pair No. 5 lasted about 2.5 h in spite of my intensive disturbances (Table 1). Further observations are needed to determine how long a bout of copulation lasts under undisturbed conditions.

Although my data are insufficient to say how long a time is necessary for the male to inseminate the female, it seems that 10 min is too short for successful insemination because

TABLE 1. Effects of artificial disturbances on *in copula* pairs. Asterisk indicates occurrence of remating. C: first copulation. R: remating. U: uncoupling. F: flight (flying female always carried male). L: uncoupled male lost previous partner even though he seemed to search for her. X: I could not follow uncoupled individuals because of rapid flights. S: I stopped observing.

Pair no.	Distance from previous copulation (m)	Time after copulation began (min)						
		0	1	3	5	10	30	150
1	—	C	UX					
2	—	C	FF	FU				
2*	1	R	F		UL			
3	—	C			FU			
3*	1	R	UL					
4	—	C	F			U		
4*	0	R	F	FX				
5	—	C	FF	F		FF	FF	FFFU
5*	0	R	FF	U				
5**	2	R			S			

duration of copulation in almost all butterflies is known to last over 30 min (Scott, above; Shields, O. & J. F. Emmel 1973, J. Res. Lepid. 12:25-64; Fukuda et al. 1982-1986, The life histories of butterflies in Japan, Vol. 1, Hoikusha, Osaka, 277 pp., Vol. 2, 325 pp., Vol. 3, above, Vol. 4, 373 pp., Japanese, English summary). If so, any male that uncouples within 30 min after copulation begins should remate with the previous partner to insure successful insemination. If this male does not find the previous partner, she will be inseminated by another male. In fact, Unno and Tanaka observed that such a female copulated again with another male.

Pair No. 5 remated twice after the 1st copulation, which lasted about 2.5 h. The male of this pair is likely to have transferred its sperm to the female's bursa copulatrix during the 1st copulation, because in butterflies most successful copulations are known to finish within 1-2 h (Scott, above; Shields & Emmel, above). If insemination did occur, the 2nd and 3rd copulations of pair No. 5 may be copulatory mate guarding behavior by the male. Copulatory mate guarding has not been reported in Lepidoptera previously (Thornhill & Alcock, above; Drummond, above), but Drummond considered that lepidopteran males might also guard their mates from the advances of other males while still *in copula*. However, in some cases where the male successfully copulates several times within 1 or 2 days, a bout of copulation may last several hours after the 2nd copulation (Svärd & Wilkund, above; Fujii unpubl.). Additional studies are needed to know whether or not repeated copulations in *S. janasi* are truly copulatory mate guarding.

Although *in copula* pairs of *S. janasi* were separated very easily by my disturbances, this is not true in other butterflies (Fujii, H. 1975, Gekkan-Mushi [52]:14-19, Japanese). Why do *in copula* pairs of *S. janasi* separate so easily? Longer copulations are probably more dangerous than shorter copulations, because *in copula* pairs are more conspicuous and less mobile and should therefore suffer higher predation. Moreover, both sexes of *S. janasi* are reddish orange in color, so they are very conspicuous on green leaves. Therefore, the easy-to-separate copulation behavior of *S. janasi* may have evolved in response to predation pressure. In favor of the hypothesis is the fact that two other orange hairstreaks, *Japonica lutea* (Hewitson) and *J. saepestriata* (Hewitson), copulate at dusk (Fujii, above; Fukuda et al., above), while *S. janasi* copulates during the day when bird predation seems much heavier (Fujii, above; Saigusa, T. 1983, 30th annual meeting of the Lepidopterological Society of Japan).

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AN EMENDED SPECIFIC NAME IN *EUPITHECIA* (GEOMETRIDAE)

Additional key words: Chile, *Eupithecia taracapa*, *E. tarapaca*.

Prof. Raúl Cortés, of the Instituto de Entomología, Universidad Metropolitana de Ciencias et la Educacion, Santiago, Chile, called my attention to an incorrect geographical name and a resulting incorrect species-group name in my 1987 paper "The *Eupithecia* (Lepidoptera, Geometridae) of Chile," Bull. Am. Mus. Nat. Hist. 186:269–363. On p. 325 I gave the type locality of the new species as being in "Taracapá" Province and Region, and proposed for it the specific name *Eupithecia taracapa*, a noun in apposition taken from the type locality. The correct geographic term is Tarapacá, and so I am emending the name of the species to *Eupithecia tarapaca*, thus replacing the incorrect *E. taracapa* Rindge 1987; both names have the same holotype. This emendation is in conformity with Articles 32(d) and 33(b)(ii) of the International Code of Zoological Nomenclature.

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